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Sensitivity, specificity, positive and negative predictive value of nasopharyngeal and throat swabs in detection of Sars-Cov-2 among infected patients

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ABSTRACT

Background: In the care of patients, early and accurate respiratory virus identification (RRI) is critical. We have previously demonstrated the feasible and responsive self-recollected nasal swabs (NS) to detect RV, but the additive advantages of the self-collected throat swabs are unknown. *Objectives*: To test the rise in auto sufficient nasal yields to the throat swabs in patients with upper respiratory (URTI) symptoms for PCR identification of RV. *Study design*: Between April 2020 and September 2020, Patients with signs of URTI self-collected NS and nylon-floated polyurethane foam swabs, completed an enquiry. Swab's reverse transcription (RT)-PCR was checked for 12 RVs in real-time. Statistical measures were used to identify, McNamara and Wilcoxon signed level. *Results*: The sample was made up of 115 paired swab nasals and throat, with at least 1 specimen being positive for RV (71/115 (62 percent), including 51 positive for both specimens, 17 positive for NS only and 3 favorable for RV only with throat swab. NS was 96 percent sensitive (95 percent CI: 88-99) compared with 76 per cent in throat swabs, $p<0.001$ (95 percent CI: 65-85). The median PCR period threshold (Ct) of 51 concordant samples was lower in NS (25.1) than in swabs of the throat (32.0). The three positive samples were high Ct (33.8, 36.2 and 38.8 both rhinoviruses) by the throat swab only. *Conclusion*: Auto collection of NS is far more susceptible to the identification of RV with RT-PCR than auto collection of throat swabs. Added neck samples do not seem to raise the diagnostic pressure in the research setting.

Keywords: Assessment sensitivity; specificity; nasal; nasopharyngeal; swab; detection; COVID-19; Infection; admitted; patients.

1. INTRODUCTION

A non-invasive, patient-accepted and receptive Respiratory Virus Identification (RVI) diagnostic approach may have significant consequences for patient treatment, epidemiology trials, and clinical investigations. RVI

diagnosis also relies on the need to produce a breathing examination taken by a clinician. However, the timing to get to a health care center with people who are sick can be complicated, and diagnosis period can be postponed, (Emerson et al., 2013) and some patients or workers can be vulnerable to infection. Responsive self-recollection approaches are known and are available to provide the means for community-based analyses of RVI epidemiology and longitudinal surveillance. Previous experiments have shown the viability, highly-accepted patient sensitivity and/or self-collected nasal swab (NS) selection of the cline (Dhiman et al., 2012; Preiksaitis et al., 2015; Akmatov et al., 2012; Lambert et al., 2008; Akmatov et al., 2011; Larios et al., 2011; Campbell et al., 2013). Nasal swab collection is likely. The function of other respiratory specimens obtained by themselves, whether alone or in conjunction with NS, is uncertain. Our previous analysis of contrasting oral gargles self-collected with NS in recipients of symptomatic RVI has indicated lower oral gargles sensitivity (Fisher et al., 2017). While Ip et al., (2020) did not equate the two kinds of specimens, (Schutten et al., 2012) both self-collected NS and throat swab used in the Population Influenza Report. In our experience there was no measurement of the additional benefit of self-collected throat swabs.

Objectives

In immunocompetent patients with upper respiratory tract infection (URTI) symptoms, we hypothesized that throat swabs will not add substantial to RVI diagnostics by testing self-collected NS and throat swabs utilizing reverse transcription inimmunocompetent patients with upper respiratory tract infection (URTI) symptoms using reverse-transcription polymerase chain reaction (RT-PCR).

Study design

Patients between April 2020 and September 2020, immunocompetent patients with three or fewer URTI signs have been prospectively admitted. Patients could participate if their symptoms had been isolated for > 4 weeks.

2. MATERIAL AND METHODS

Following informed consent, detailed directions and resources for gathering NS and neck swabs were given for participants. After instillation of 0.5 mL of usual savory saline in one nose and rotation of the swab five seconds into the anterior nostril, the participants obtained nasal specimens of polyurethane foam nasal swab (Puritan Medical Products Co., LLC; no. 25-1805-1PF-SC2 Arrow). Throat swabs have been obtained using nylon flocks (Copan Diagnostics No.502CS01) and inserted in universal transport media 2-3 times in each tonsil region by swabbing the back of the throat. In the past, all forms of samples have proven themselves to be stable for 7 days at room temperature, and students are moved to the laboratory according to their suggestions by manufacturers. A detailed symptom survey was also carried out by participants, as mentioned previously (Kuypers et al., 2004; Kuypers et al., 2005; Kuypers et al., 2006; Kuypers et al., 2007; Lu et al., 2008).

Respiratory virus detection

As previously described, samples were analyzed in the laboratory. Twelve RVs were evaluated using laboratory RT-PCR experiments in real-time: ASV, parainfluenza 1–4, influenza A and B, adenovirus, coronavirus, rhinovirus (HRV), meta-pneumonia-virus and Boca virus (Kuypers et al., 2004; Kuypers et al., 2005; Kuypers et al., 2006; Kuypers et al., 2007; Lu et al., 2008). Samples is regarded as being positive when the threshold of the PCR period (Ct) value was smaller than 40 on the basis of defined cut-offs for laboratory experiments.

Statistical analysis

The detection of an RV of each type was deemed to be truly optimistic. For demo diagrams, symptoms, and RV information, informative and summary statistics have been used. For the estimation of importance, the (categorical) rank tests of McNamara and Wilcoxon (paired Ct values) were used.

3. RESULTS

There were prospectively one hundred and fifteen NS and neck swabs from 63 (68.2 percent female). The total time of the processing and care of swab was 1 day (IQR 0–1). The 21 participants (33.3 percent) sent more than one episode of symptoms of URTI for specimens. A total of 86 (74.8 percent of 115) symptom surveys were conducted.

Symptoms

At the period of the specimen col- lection the median amount of symptomatic days was two days (IQR 1–3). Table 1 indicates how many people with different symptoms have been detected and the ratio with each symptom vs. RV not observed. There was considerable correlation with the presence of rhinorrhea, nasal / sinal inflammation, and sneezing.

Table 1 Reported symptoms and association with respiratory virus detection.

Symptom	Total, N (%) a	RV+, N (%) b	RV-, N (%) b	p-value
Respiratory Rhinorrhea	71 (82.6)	51 (94.4)	20 (62.5)	<0.001[c]
Nasal/Sinus Congestion	67 (77.9)	46 (85.2)	21 (65.6)	0.035
Sore Throat	65 (75.6)	42 (77.8)	23 (71.9)	0.54
Cough	60 (69.8)	41 (75.9)	19 (59.4)	0.11
Sneezing	57 (66.3)	44 (81.5)	13 (40.6)	<0.001
Sputum	55 (64.0)	35 (64.8)	20 (62.5)	0.83
Any Systemic	77 (89.5)	48 (88.9)	29 (90.6)	1.0[c]
Headache	55 (64.0)	38 (70.4)	17 (53.1)	0.11
Fatigue	54 (62.8)	35 (64.8)	19 (59.4)	0.61
Myalgia	38 (44.2)	26 (48.1)	12 (37.5)	0.34
Fever	30 (34.9)	19 (35.2)	11 (34.4)	0.94
Diarrhea	8 (9.3)	3 (5.6)	5 (15.6)	0.14[c]

Respiratory virus detection

Of the 115 paired specimens, 71 (61.7 percent) were positive for either RV in one of them or for both. In both instances, only one RV has been observed. Table 2 illustrates how individual RV is spread and how RV detections and sensitivities by form and specific virus have been broken down. Table 2 shows in 68 (59.1%) of NDs were positive, and in 44 (38.3%) of those pairs (p<0.001) the throat swabs were positive. Although there were low numbers of individual RVs that make statistical research hard, NS demonstrated the same or better sensitivity (adenovirus) as the throat swab (all other RVs). The patients with such signs including sore throat or rhinorrhea did not vary greatly with the sensitivity of the specimen type (data not displayed).

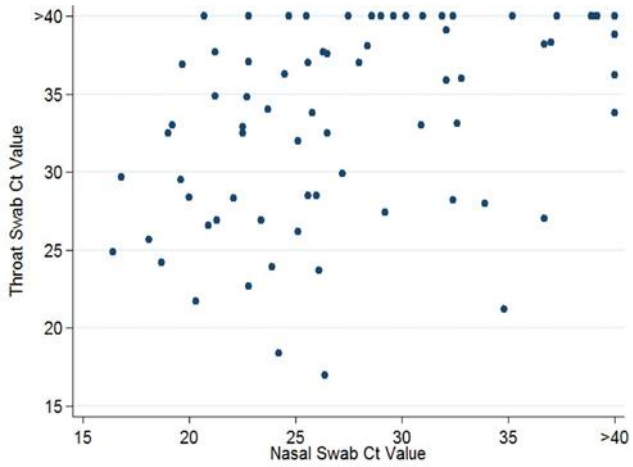
Table 2 Sensitivity of nasal swab and throat swab specimens by virus type.

	Total, N (%)	Both positive	NS+, TS -	TS+, NS-	NS	TS	P value
Any	71(100)	51	17	3	95.8 (88.1-99.1)	76.1(64.5-85.4)	0.002
HRV	39(54.9)	29	7	3	92.3	82.1	
CoV	14(19.7)	10	4	0	100	71.4	
Flu	7(9.9)	6	1	0	100	85.7	
PIV	4(5.6)	2	2	0	100	50.0	
MPV	2(2.8)	1	1	0	100	50.0	
BoV	2(2.8)	1	1	0	100	50.0	
RSV	2(2.8)	1	1	0	100	50.0	
ADV	1(1.4)	1	0	0	100	100	

* P-values and 95% CI only calculated for all viruses together given small numbers of other individual respiratory viruses. NS: nasal swab; TS: throat swab; CI: confidence interval; HRV: human rhinovirus; CoV: coronavirus; Flu: influenza A or B; MPV: meta-pneumo-virus; BoV: boca-virus; RSV: respiratory syncytial virus; PIV: parainfluenza virus 1–4; ADV: adenovirus.

The mean value of CT was 25.9 (IQR 22.5 – 31.3) in the positive samples of the RV relative to 32.5 for the swabs in the throat (p < 0.0001) (IQR 26.9–36.2). 17 pairs were accurate just for NS, compared to only 3 pairs valid for throat swabs. In that case, all nasal and

throat signs were observed and both of the viruses had elevated Ct (33.8, 36.2, and 38.8) values. The median Ct values were different, depending on the compatibility of the specimens: the median Ct was lower for NS (higher viral concentration) than the other positive specimen for NS, with comparable findings for throat swabs (Fig. 1). The median Ct values for NS were different. Median Ct in NS versus gargantuan sponges did not distinguish between evil throat patients and rhinorrhea patients (NS: 26 [IQR 22.8–32.7] and 27 [IQR 23.6–32.2]; neck swab, respectively: 32.8 [IQR 27.8–36] and 33.1 [IQR 27-36.6]). In NS there was no association of Ct to throat swabs (coefficient of correlation: 0.214, p = 0.13).



Specimen	N	Median Ct	Range	IQR
Concordant + NS	51	25.1	16.4-37.0	21.25-28.2
Concordant + TS	51	32.0	17.0-39.1	26.9-36.0
Only NS+	17	30.2	20.7-39.2	27.5-35.2
Only TS+	3	36.2	33.8-38.8	N/A

Figure 1 Comparison of nasal vs. throat swab cycle threshold values in 71 pairs positive by at least one specimen type

4. DISCUSSION

In this prospective study, we have observed that the throat swabs do not greatly lead to the RV identification by RT-PCR in 115 pairs of auto collated polyurethane nasal and nylon flocculated throat sampling in patients with respiratory symptoms. We have noticed Ct values in NS to be considerably smaller, which suggests higher viral levels. Increased chance that specific symptoms were observed by one approach relative to another (nasal cough, sore throat, etc.), while nasal and sneeze symptoms in those with RV were more frequent compared to those with RV detected. This research has had limitations. There were several episodes for a variety of viruses, which rendered it impossible to generalize findings for all viruses. In an H5N1 analysis, De Jong et al., (2006) recorded that the pharyngeal specimen collected by the provider is more optimistic and had more viral charges than those collected from nasals. We have just 7 un-typed reports of influenza, which implies that this result will not be evaluated. Secondly, while previous data suggest that our self-collected NS equals samples collected by the vendor, we did not test this for throat swabs. This research emphasizes, however, on the real-world application of samples gathered and provides an overview into the virus load and diagnosis in two different breathing areas. Fourth, for nasal and throat (nylon flocked), we used separate swabs. Our previous experiments have demonstrated comparability with providers of collected neuronal washes and at the period the norm of flocked neck swaps; but various styles of swab could deliver different outcomes. Nose swabs are selected based on improved comfort and patience and acceptability.

5. CONCLUSION

Overall, in addition to NS, we observed that the collection of throat swabs produced a minimum identification of RVI. Our findings, along with the added responsibility of obtaining a second sample and extra costs for processing, only help the use of self-assembled NS in external and community-based RV testing.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval

The study was approved by the Medical Ethics Committee of King Saud University (ethical approval code: FH1587 IR#5149).

Funding

This study has not received any external funding.

Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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